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MC Report 004

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PARKA II

A BRIEFING REPORT

November 1970

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OCEAN SCIENCE PROGRAM

MAURY CENTER FOR OCEAN SCIENCE

Department of the Navy

Washington, D.C.

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MC Report 004

LONG RANGE ACOUSTIC PROPAGATION PROJECT

BRIEFING REPORT
on
PARKA II

NOVEMBER 1970

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OCEAN SCIENCE PROGRAM
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ABSTRACT

(U) The PARKA II measurement program extended the testing of the Fleet Numerical Weather Central (Monterey) long range acoustic propagation model, begun under PARKA I, to other seasons and propagation paths. PARKA II also measured the stability and phase coherence (over a vertical aperture) of long range acoustic paths, investigated the depth dependence of low frequency acoustic ambient noise and demonstrated advances in techniques and instrumentation for real-time acoustic data processing.

(U) The PARKA I propagation model testing was largely limited to a North-South path. The PARKA II propagation loss measurements included additional paths involving different bottom topography. As in PARKA I, concurrent acoustic and oceanographic measurements were made. Acoustic sources used in the experiments were air-dropped and ship-dropped explosive sources and ship-towed continuous wave projectors. Receivers consisted of a vertical line of individual hydrophones suspended from FLIP.

(C) The PARKA experimental program have achieved the following significant results:

(1) Established a three season acoustic/oceanographic data bank.

(2) Tested an interim Navy standard for reliable prediction of propagation loss.

(3) Investigated the dependence of detection performance on sensor depth.

(4) Investigated the feasibility of signal-to-noise ratio enhancement through vertical directionality.

Other non-acoustical accomplishments are:

(1) Demonstrated feasibility of real-time data reduction in a multi-ship investigation as a routine procedure.

(2) Demonstrated feasibility of satellite data relay, ship-to-shore.

INTRODUCTION

(U) This briefing is a report on PARKA II, the second series of PARKA experiments conducted by the Long Range Acoustic Propagation Project, LRAPP, RDT&E Project 2408 of Program Element 63701N. The end objectives of the LRAP Project are validated technological options for systems, techniques, survey procedures and facilities to provide substantial improvements in determining the performance of long-range active and passive sonar systems.

(C) The LRAP Project is achieving its end objectives by establishing the feasibility and operational utility of:

(a) An environmental/acoustic model, which can be used to reliably predict the performance of and assure the most advantageous depth of both fixed and deployable sonar systems.

(b) Appropriate facilities for the purpose of collection, storage, analysis and dissemination of acoustic and oceanographic data and predictions relating to the performance of fixed and deployable sonar systems.

(C) At the inception of the LRAPP, no acoustic propagation model had been thoroughly validated at any range and no model had been tested against at-sea measurements to distances greater than about 300 miles. LRAPP established an interim prediction model for propagation and initiated a measurement program for the validation and improvement of the model. The interim model, based on ray theory and on environmental data from all Navy sources, covered ranges to 125 nautical miles. Long range detections of targets made it apparent that validated propagation models must be developed to cover such ranges. The PARKA (Pacific Acoustic Research, Kaneohe – Alaska) program was initiated to supply the simultaneous measurements of environmental conditions and propagation loss that were required for extension of the model. The first series of PARKA experiments, PARKA I, were completed late in 1968 and a briefing report issued in May 1969 as Maury Center Report No. 001. The propagation path selected for PARKA I due north from Hawaii to Alaska, was chosen as providing distances and diversity in environmental conditions requisite to model validation.

(U) The PARKA I and PARKA II experiments are the most concerted effort to date to establish deterministic relationships between the environment and the aspects of acoustic propagation that are crucial to long range submarine detection. The PARKA experiments are unprecedented in scope and detail.

SUMMARY

(C) The data from all of the PARKA experiments demonstrate that long range surveillance systems can achieve significant performance improvements through judicious placement of the array in the water column; and further, PARKA has shown that a dual array installation (one near the channel axis and one near the bottom of the sound channel) would be complementary. That is to say, that although optimum receiving depth varies in a complex manner with season, source depth, frequency, track, and range, these two depths offer suitable enhancing features so that each would be several dB better than the other under some conditions. Some of the more important aspects of the data are shown in Table I.

Table I
Mean Propagation Loss (dB) for 100 Hz

RECEIVER DEPTH	SHALLOW SOURCE (60 FT)			
	500 nm		1400 nm	
	S	A	S	A
2500 ft.	106	106	110	107
10,800 ft.	104	103	106	111
	DEEP SOURCE (500/800 FT)			
	500 nm		1400 nm	
	S	A	S	A
2500 ft.	100	103	102	103
10,800 ft.	98	101	107	111-115

S = Summer

A = Autumn

Receiver Depth Effects

(C) a) 10 to 500 nm – In this range interval, for non-bottom limited conditions, the 10,800 foot receiver depth generally showed the least propagation loss for deep target depths. This was true for both PARKA I and II and therefore there was no seasonal change.

It is difficult to draw general conclusions regarding best receiver depth for shallow targets; however, both the 300 foot receiver and the 10,800 foot receiver showed better performance than the 2500 foot receiver. The 300 foot depth receiver showed lower propagation loss in the convergence zones, but at the ranges between the zones the 10,800 foot depth receiver had lower loss. Along tracks where bottom effects have a significant influence, transmission is complicated and no one hydrophone depth showed an overall advantage.

(C) b) 500 to 1600 nm – For sources at these long ranges (and to the north), the best receiving depth depends on both season and source depth. For shallow sources the 10,800 foot receiver has less loss in the summer but the near-axis receiver has less loss in autumn and winter. For deep sources, the near-axis receiver has less loss in all seasons.

Source Depth Effects

(C) Generally, the deeper source propagated as well as or better than the shallow source to all receiving depths. Exceptions were noted however in that on occasion the shallow source showed less loss than the deep source to the 300 foot receiver.

Source Frequency Effects

(C) a) Propagation loss at 25 Hz was observed to be 8 to 12 dB greater than that observed at 50 Hz for all runs made with a shallow (60 ft.) source and for those made with 800 foot depth aircraft dropped SUS charges. The effect was not present with 3 lb. TNT charges detonated at 500 feet. This result is thought to be caused by a combination of inaccurate source calibration and image interference effects. Analyses are underway to investigate the causes for the excess losses.

(C) b) 50 Hz and 100 Hz propagation losses were generally comparable for deep sources; however, shallow sources showed considerable irregularity. For some paths, the difference was 3 to 5 dB less loss for 100 Hz, probably for the same reasons mentioned in (a).

(C) c) The propagation loss for 180 Hz is generally greater by 3 to 5dB than that for 100 Hz. The major exception occurs for shallow sources at ranges less than 500 miles where the losses are more or less comparable.

(C) d) Propagation loss for 400 Hz is typically greater than that for 100 Hz and generally increases with range. 5 dB differences are common at short range increasing in one case to approximately 15 dB at 1000 miles (event 13-2).

Ambient Noise

(C) Data taken with AUTOBUOY showed no significant variation in ambient noise level with depth between 20 and 1200 Hz. Ambient noise data recorded aboard FLIP from 2500 foot and 10,800 foot depth phones confirmed this conclusion.

PARKA I

(U) The following brief review of PARKA I is presented to provide the background of the PARKA II Experiment. The reader is referred to Maury Center Report No. 001 (May 1969) and No. 003 (Nov. 1969) for more detailed information on PARKA I.

(C) PARKA I was conducted to examine our ability to predict acoustic propagation loss from a knowledge of environmental factors and the source-receiver geometry. Two sets of propagation loss measurements were made during oceanographic summer conditions over the same 2000 nautical mile track from Kaneohe, Hawaii, due north to Alaska. One set of measurements was made with explosive acoustic sources dropped at close intervals from a ship. The other set of measurements was made with a ship-towed continuous wave projector. The research vessel FLIP served as a platform for receivers suspended at approximately 300, 2500 and 10,000 feet depth in the 18,000 foot deep water 330 nm north of Kaneohe.

(U) Oceanographic parameters were measured at the site of FLIP, at the source and along the track by ships and aircraft.

The Fleet Numerical Weather Central (FNWC) propagation model was exercised with the measured environmental parameters to produce predicted propagation loss curves.

(U) Good agreement was obtained at 100 Hz between the FNWC predicted losses and those measured for the long ranges. The movement of FLIP with ocean currents during the experiment prevented detailed comparison where there were significant bottom interference effects.

(C) The PARKA I results demonstrated that there can be an optimum receiver depth for a given environment and source depth. For summer conditions, the 10,000 foot receiver depth was consistently better than the 2500 receiver for the 60 foot source depth along the track from FLIP to Alaska, whereas the propagation from the deep source suffered less loss to the on-axis receiver at long ranges.

(C) PARKA I accomplished the following:

(1) Extended and tested the FNWC model to ranges of 1600 nm.

(2) Demonstrated the existence of optimum receiver depths.

(3) Established a bank of concurrent oceanographic/acoustic data for the Northern Pacific.

(4) Achieved real-time processing and plotting of measured propagation loss curves.

ORGANIZATION

(U) The participants and their roles in PARKA II are shown in Figures 1 and 2. Fourteen activities took part in the experiments. Figure 1 shows the relationship between the Project Director, Dr. Hersey, the Chief Scientist, Dr. Nichols, and the Deputy Chief Scientists for PARKA IIA and IIB, Mr. R. W. Hasse and Dr. F. N. Spiess, respectively. Figure 2 depicts the large numbers of activities cooperating in the PARKA II experiments.

PARKA II OBJECTIVES

(C) The PARKA II experiment was planned to:

(1) Extend the FNWC propagation model validation to other seasons and other propagation paths, including East-West paths, paths with topographic blockage and longer range paths than those used in PARKA I.

(2) Investigate acoustic transmission stability and coherence at spatially separated receivers.

(3) Determine optimum receiver depth.

(4) Determine depth dependence of ambient noise.

PARKA II EXPERIMENT DESIGN

(U) To achieve the PARKA II objectives, the measurement program had to be extended beyond the scope and character of the PARKA I program. Extension of the propagation model validation required the use of new and longer tracks in new environments and seasons. Investigation of spatial and temporal coherence of acoustic transmissions required a fixed array of receivers. Broad scientific planning of the PARKA II experiment was accomplished by a group which included Dr. R. H. Nichols (BTL); Mr. R. W. Hasse (USL); Dr. F. N. Spiess (MPL); Dr. W. A. Hardy (University of Hawaii); and Dr. E. E. Hays (WHOI) in addition to Dr. J. B. Hersey and his staff at the Maury Center.

(C) The experiments were planned to use Sea Spider, a tri-moored, semi-rigid, stable platform designed to allow placement of hydrophones at any depth in the ocean. Sea Spider was to be implanted at the same location occupied by FLIP during PARKA I – in 18,000 feet of water 330 miles north of Kaneohe.

(C) The tracks to be used in PARKA II were:

(1) Four round-trip aircraft runs dropping charges at intervals of eight nautical miles between: (a) Sea Spider and Adak; (b) Sea Spider and Seattle; (c) Sea Spider and San Diego, and (d) due north from Kaneohe.

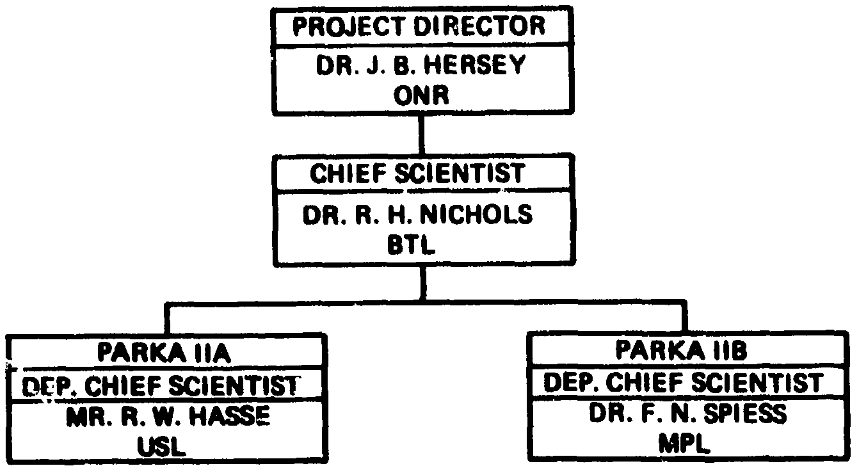

Figure 1. PARKA II Organization

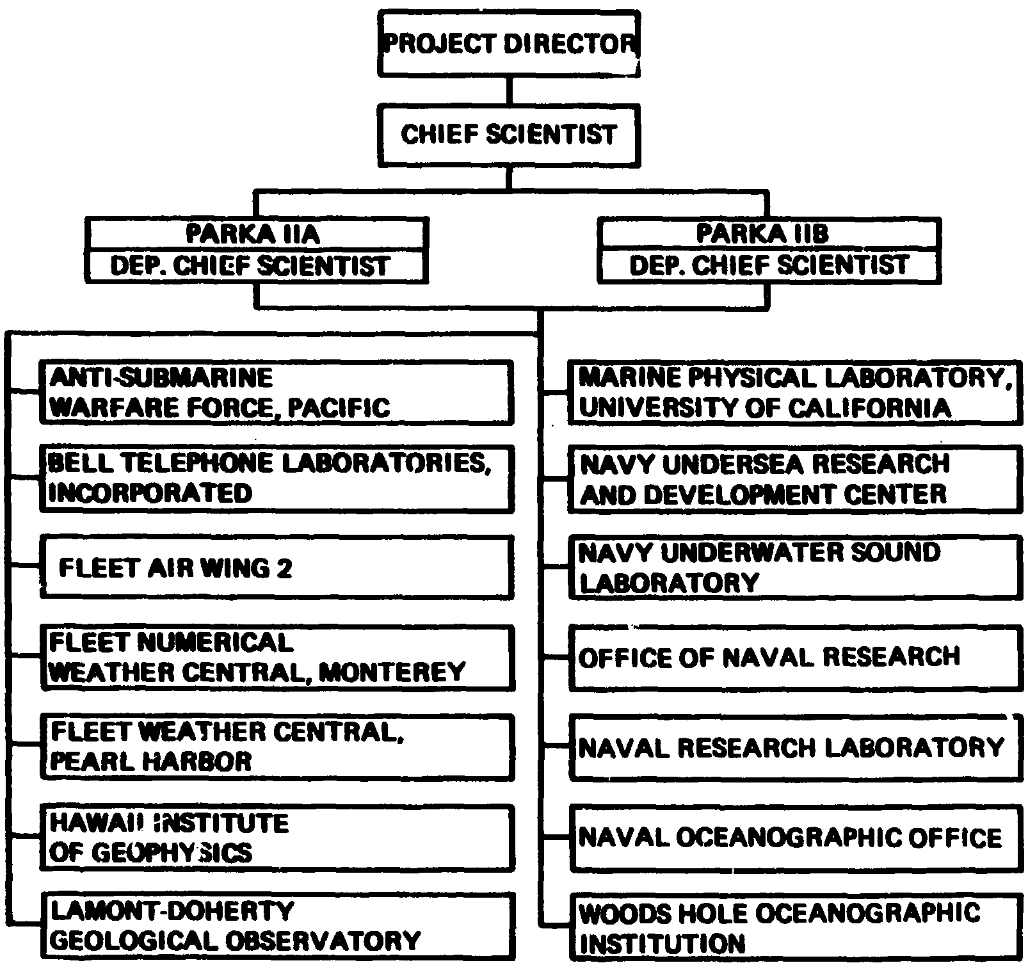

Figure 2. PARKA II Organization

(2) A series of ship runs to 500 nmi on several bearings from the Sea Spider, dropping charges at intervals of less than a mile for detailed measurements.

(3) A repeat of the ship runs with a towed CW projector operated simultaneously at 165 Hz and 185 Hz.

(C) Bottom reflection loss measurements were to be made in the vicinity of the receiving array.

(C) Array performance factors were to be evaluated by measurement of the coherence and stability of the received signals and of noise at combinations of the hydrophones distributed over Sea Spider. For these measurements, the source was to be a CW source towed by the ship from Sea Spider to 500 nm range and also operated with the ship hove-to at fixed stations along the path.

(U) Measurements of ambient noise were to be made throughout.

(U) As in PARKA I, intensive measurements of oceanographic parameters were to be made along all tracks and at the receiving array site during the experiments.

(U) The method of improving the propagation model, using the PARKA II experimental results, is shown in Figure 3.

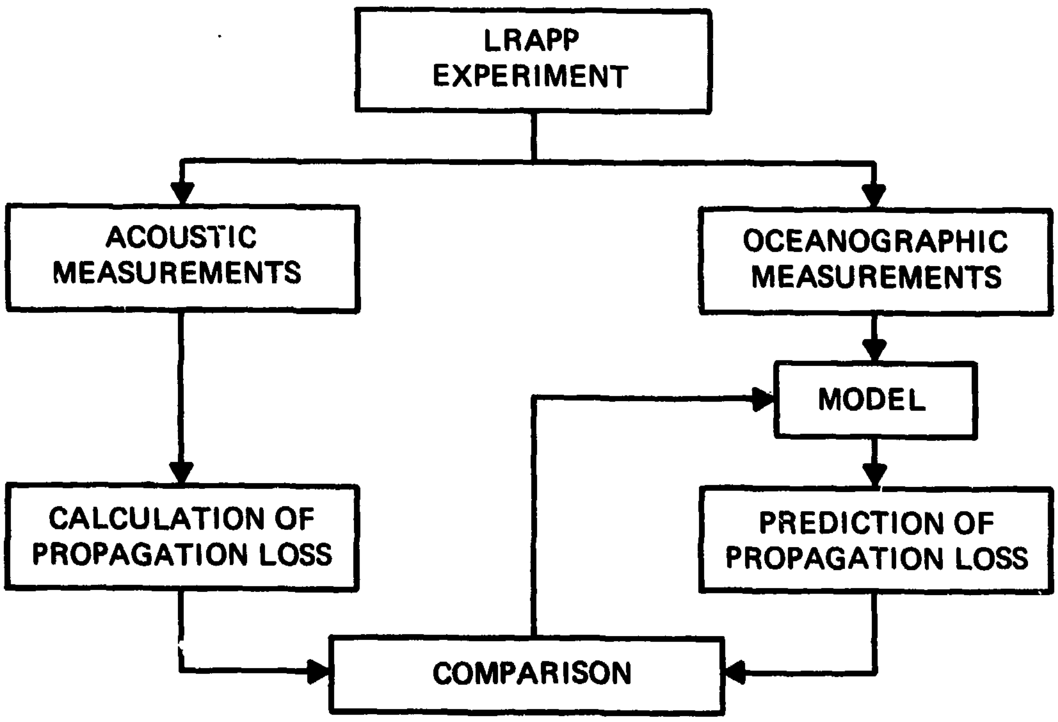

Figure 3. Acoustic Prediction Modeling

PARKA II CONTINGENCY PLANS

(C) When the implantment of Sea Spider proved unsuccessful, the PARKA II experiment plan was modified to use FLIP, moored 330 nm north of Kaneohe, as an approximately fixed platform for receivers suspended near 300 feet, 2500 feet, and 10,000 feet. While this arrangement precluded making those studies of coherence which required a three-dimensional distribution of receivers, most of the basic measurements could still be made.

(C) The autumn experiment was redesignated PARKA IIA. It was to consist of simultaneous propagation loss and environmental sampling over: (1) three long range tracks to Adak, San Diego and due north from Hawaii and (2) a series of ship runs to 500 nm on several bearings from FLIP.

(C) The winter experiment, designated PARKA IIB was to repeat the due north PARKA I and PARKA IIA track and measure stability and vertical coherence of CW transmission over essentially fixed paths of 100, 200 and 500 nm.

PARKA II EXPERIMENTAL PROGRAMS

(C) The principal features of the PARKA IIA (Autumn) and PARKA IIB (Winter) experiments are outlined in Table II along with those of the earlier PARKA I experiment.

Table II
The Parka Program

PERIOD	PURPOSE
PARKA I	
7/1/68 to 8/15/68	Environmental sampling and prediction
8/15/68 to 8/27/68	Acoustic propagation using air gun source or explosives plus environmental sampling
8/28/68 to 9/8/68	Acoustic propagation using CW source and explosives plus environmental sampling
9/8/68 to 9/21/68	Bottom reflectivity measurements plus long baseline acoustic coherence measurements.
PARKA IIA	
11/69 to 12/69	Extend the PARKA I measurements along different and longer tracks for autumn conditions.
PARKA IIB	
3/2/70 to 3/20/70	Transmission fluctuation measurements, coherence measurements over vertical aperture and extend PARKA IIA to winter conditions.

(C) Simultaneous propagation loss and environmental data along the north-south, Kaneohe-to-Alaska track have now been obtained for three seasons. PARKA I provided summer measurements along the North-South track. The PARKA IIA and PARKA IIB experiments have provided simultaneous oceanographic/acoustic data for that track and also for other tracks radiating from a point north of Hawaii. The tracks used in PARKA IIA and IIB are illustrated in Figure 4,(a) and (b), respectively.

(C) In addition, the PARKA IIA provided high resolution propagation loss measurements at ranges less than 500 miles where convergence zones are prominent and also provided measurements of ambient noise as a function of depth.

(C) PARKA IIB, in addition to measuring winter propagation loss over the PARKA IIA tracks, and a track from Flip to Seattle, obtained data on transmission stability and signal coherence over a vertical aperture at the sound channel axis.

(U) As in PARKA I, detailed environmental measurements were made along the tracks concurrently with the propagation loss measurements in order to provide data for refinement of the FNWC propagation model.

(C) The noise measurements and vertical coherence measurements provided data which will be useful in the selection of array depth for fixed surveillance systems.

(C) The PARKA IIA (Autumn) propagation loss measurements were made for the parameters given in Table III.

Table III
Parameters For PARKA IIA (Autumn) Propagation Loss Parameters

Source Depth (ft.)		Hydrophone Depth (ft.)	Analysis Frequency (Hz)
Ship	Aircraft		
60 500	60 800	300 2500* 10,800	25 50 100 180 400

*Four hydrophones were suspended between 2500 and 2600 foot depths.

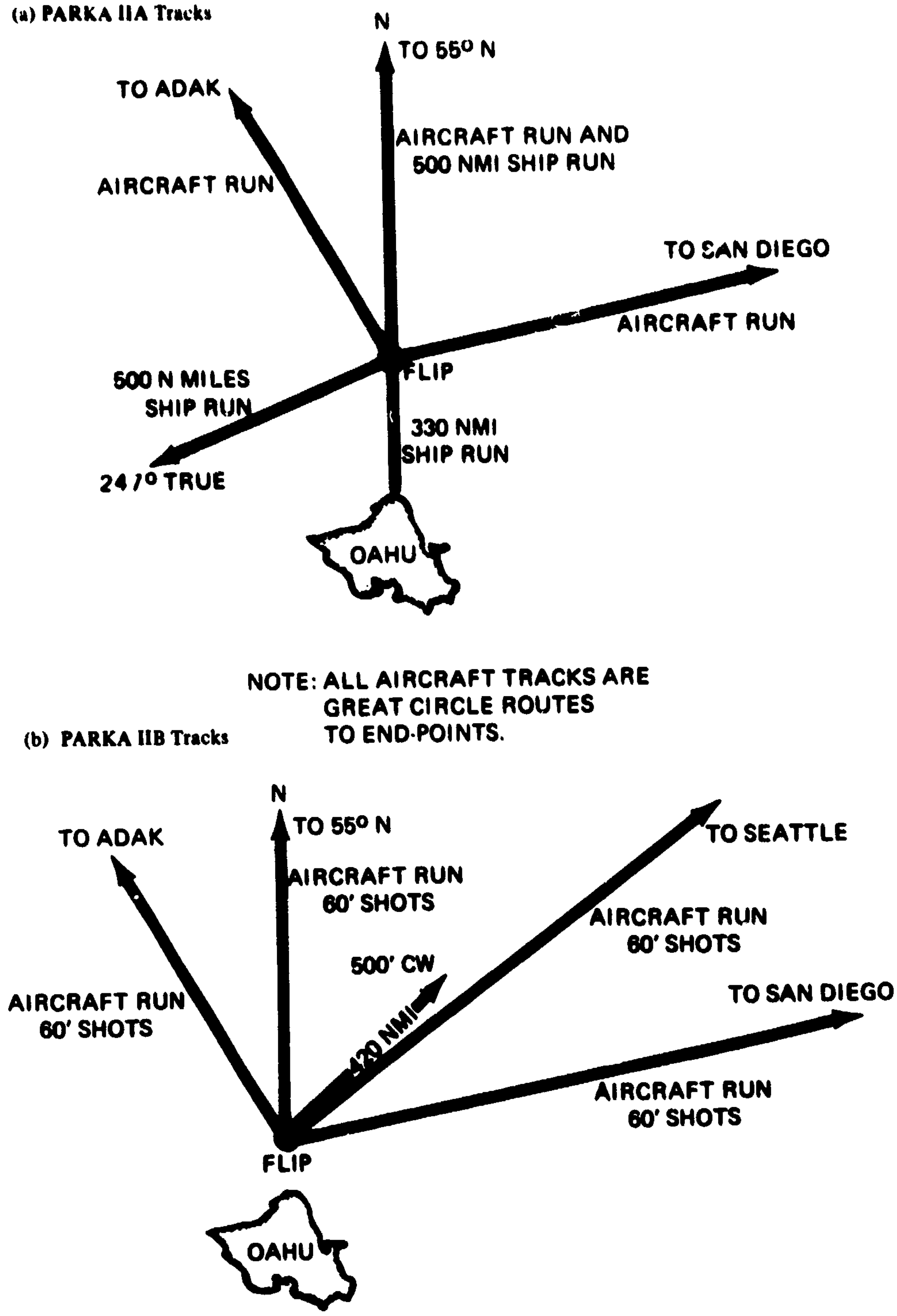

Figure 4. PARKA II Tracks

These parameters were chosen to be closely coincident with those used in PARKA I (Summer) to facilitate comparison of the results from the two exercises.

(C) The PARKA IIB (Winter) pr... ...tion loss and coherence measurements were made for the parameters given in Table IV.

Table IV
PARKA IIB (Winter) Experimental Parameters

Source Depth	Hydrophone Depth (ft)	Analysis Freq. (Hz)
Propagation Loss: 60' air-dropped SUS	2500 & 10,800	100
Coherence & Stability: 500' CW	Four hydrophones at sound channel axis. Vertical separations. 8 ft., 30 ft. and 60 ft. (See Fig. 16)	178 400

(U) Ambient noise measurements were made in the PARKA IIA (Autumn) experiment with AUTOBUOY, a self-contained, programmable, deep-diving instrument package capable of sampling acoustic background as a function of depth to 25,000 feet.

(U) Throughout the PARKA I and II experiments propagation loss data were processed in real-time. During PARKA IIA automatic data processing capability was augmented by the installation of a CALCOMP plotter aboard the SANDS.

(U) Oceanographic data were relayed to shore four times daily for further transmittal to a center for processing.

(U) An additional data handling experiment conducted during PARKA IIA consisted of using a satellite communications link (Figure 5) to relay real-time information from the hydrophone via the SANDS to processing equipment at USN/USL in New London.

PARKA RESULTS

Model Validation

(C) A primary objective of the PARKA program is the development and validation of a prediction model, or models, of propagation loss for fixed surveillance systems. The following figures present for a comparison a few of the loss curves predicted by the FNWC model and the corresponding data from the PARKA IIA experiment. The environmental

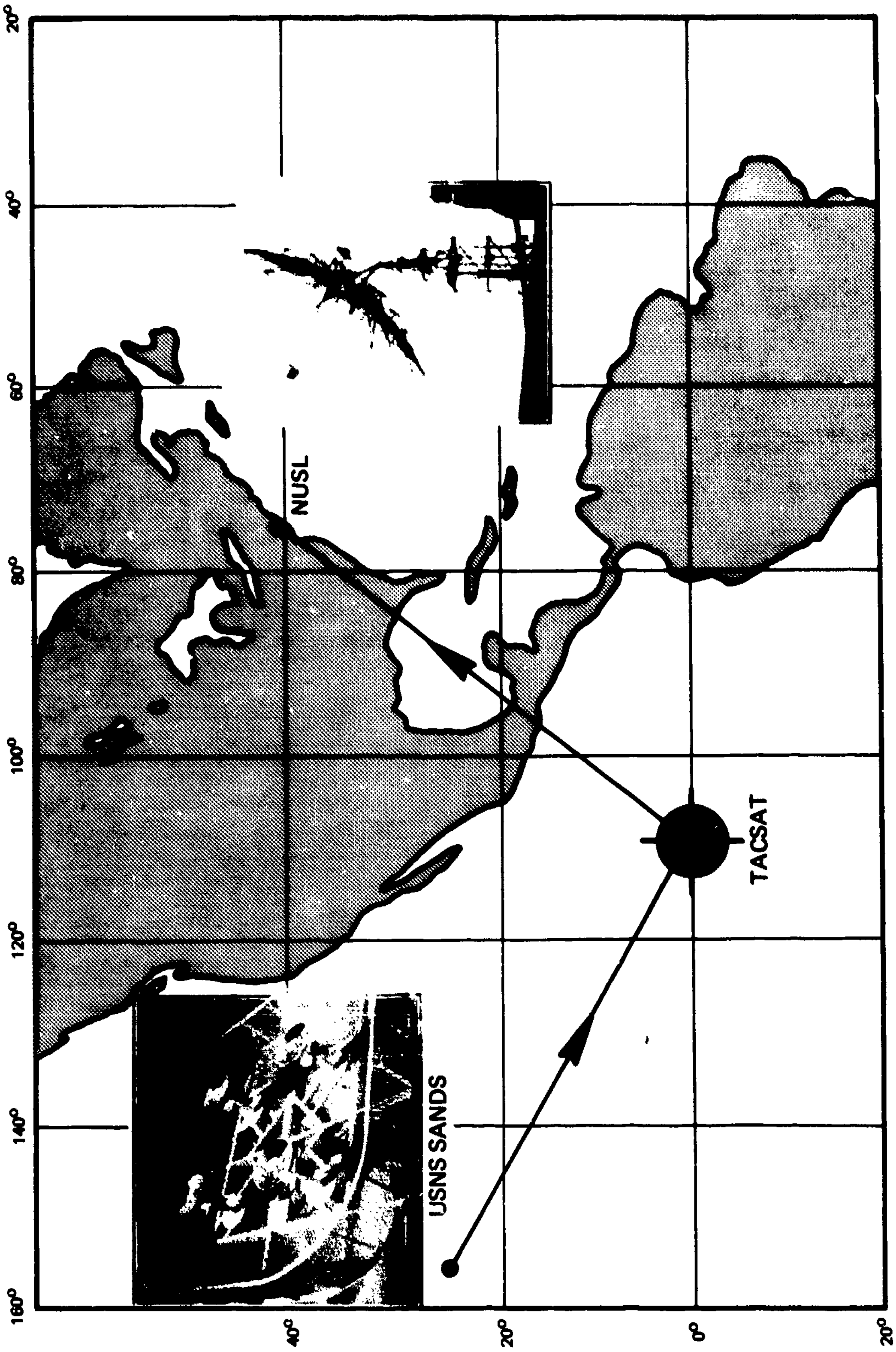

Figure 5. Satellite Data Link

inputs to the FNWC model for these cases are archival rather than the actual data taken in the PARKA IIA exercise, since the FNWC model had not been exercised with the field data as of the time of preparing these figures.

(C) Figure 6 presents comparative curves for 100 Hz loss in ranges from zero to 500 nm along the track due north from FLIP for a source at 500 ft. depth and receiver near the channel axis, 2563 ft. This is a situation in which the bottom has little influence.

(C) The locations of the convergence zones, their peak levels, their width and their gradual loss of identity exhibit good agreement between the measurements and the predictions. The small differences between prediction and measurement in the valleys between convergence zones are well within the limits to be expected, even with very good knowledge of bottom loss characteristics.

(C) For the track to the south of FLIP, the rising bottom is of great influence. Figure 7, showing a lack of agreement between the model prediction and measured loss, demonstrates our present inadequate description of the acoustic characteristics of the bottom.

(C) Figure 8 may be examined to compare the measured loss at 100 Hz with that predicted by the FNWC model for the deep (800 ft.) source and near-axis receiver for the path between FLIP and Adak. Agreement is seen to be good (mean within 1 to 2 dB) for all ranges.

(C) Figure 9 makes a comparison of the measured data with the FNWC predictions at 100 Hz for the deep (800 ft.) source and near-axis receiver for the path between San Diego and FLIP. The agreement is good to 1000 nm, but the model does not predict the large swings in measured loss beyond 1000 miles which may be caused by differences between real and assumed topography.

(C) Figure 10 shows measured and predicted loss to the deep (10,800 ft.) receiver from the deep (800 ft.) source along the Adak track. Agreement can be seen for ranges from 300 to 800 miles. Measured data is sparse from 800 to 1050 miles and measured propagation loss exceeds the predicted by about 6 dB from 1200 to 1300 miles.

Table V summarizes the results of the above comparisons.

(C) The FNWC model, using archival data for the environmental inputs, was successful in predicting PARKA IIA deep source, axis receiver measurements along the due North and Adak tracks. The degree of success was comparable to that of the FNWC prediction for the PARKA I due North track deep source, axis receiver situation wherein the environmental inputs were those actually measured simultaneously with the propagation loss measurements.

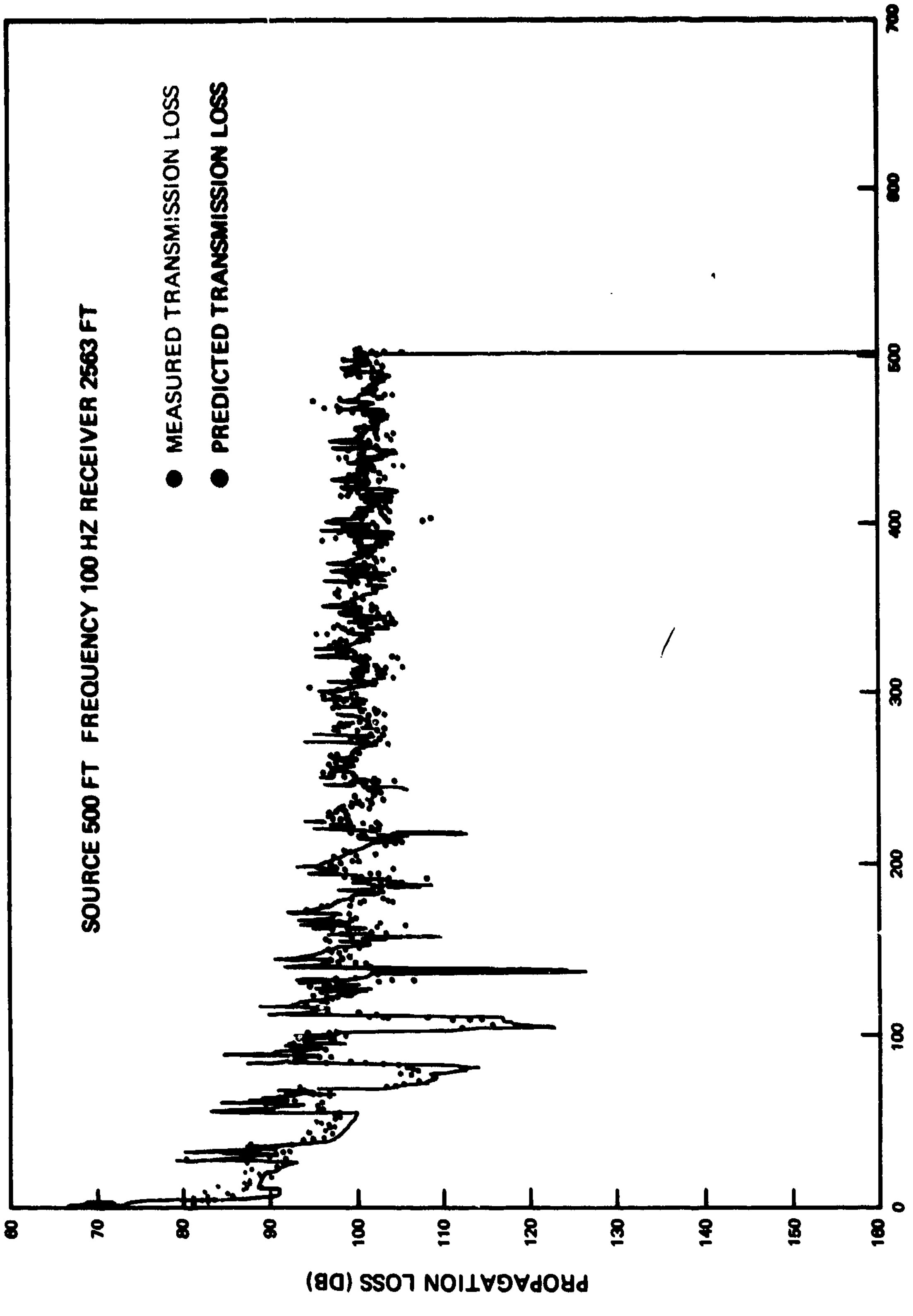

Figure 6. Measured and Predicted Losses – Due North Track

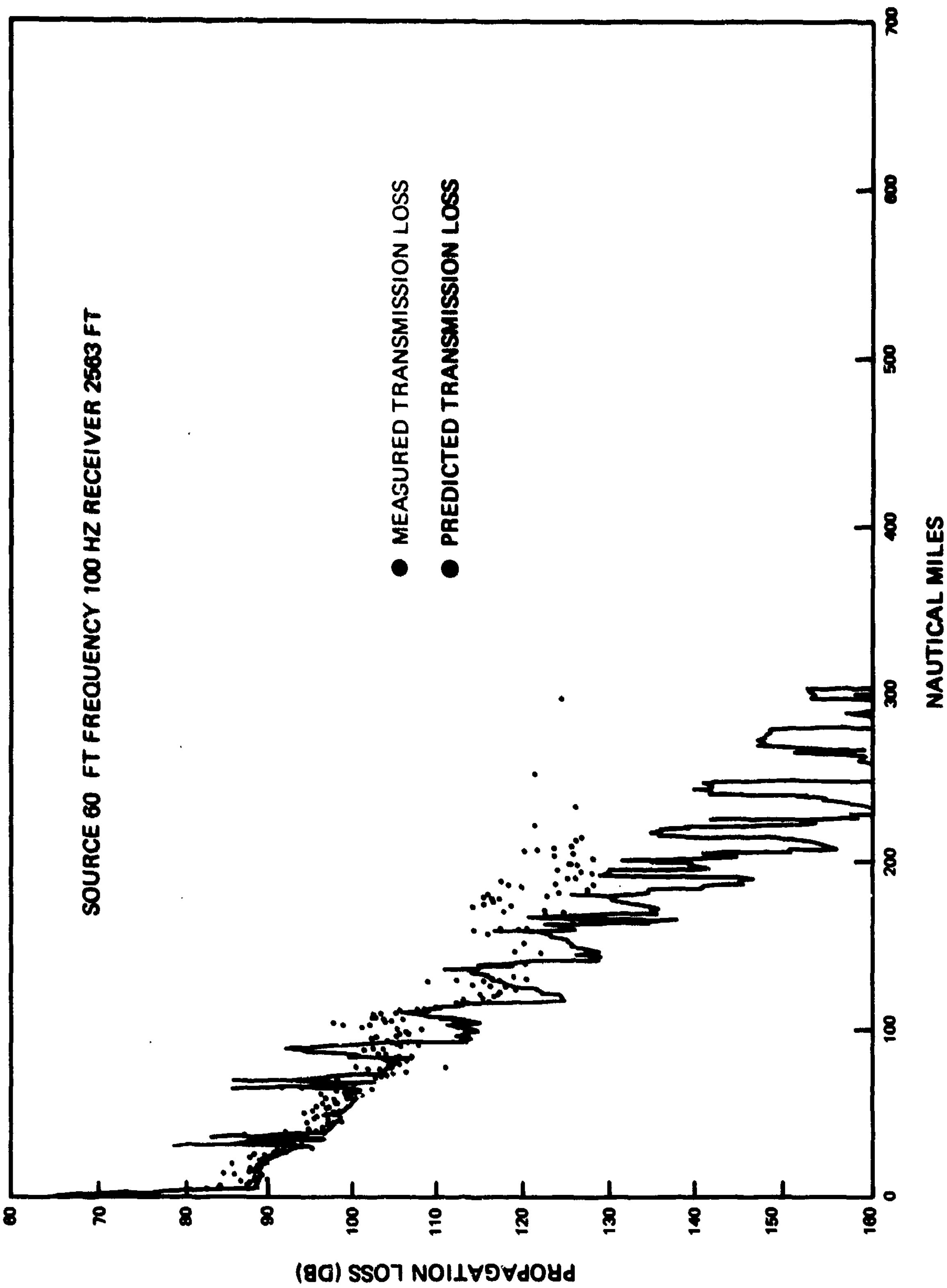

Figure 7. Measured and Predicted Losses – Due South Track

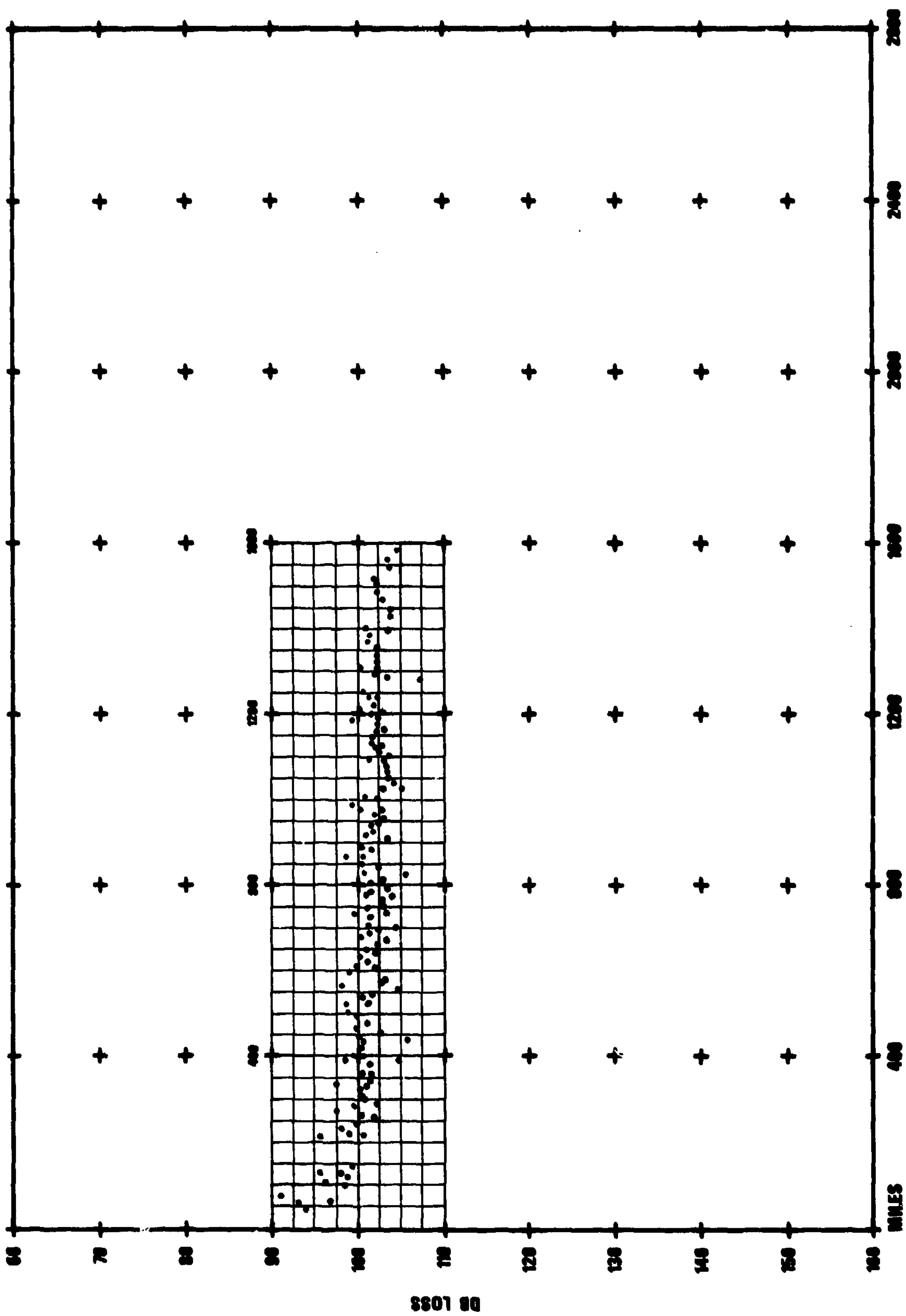

Figure 8. Measured and Predicted Loss Along Adak Track for Deep Source/Axis Receiver

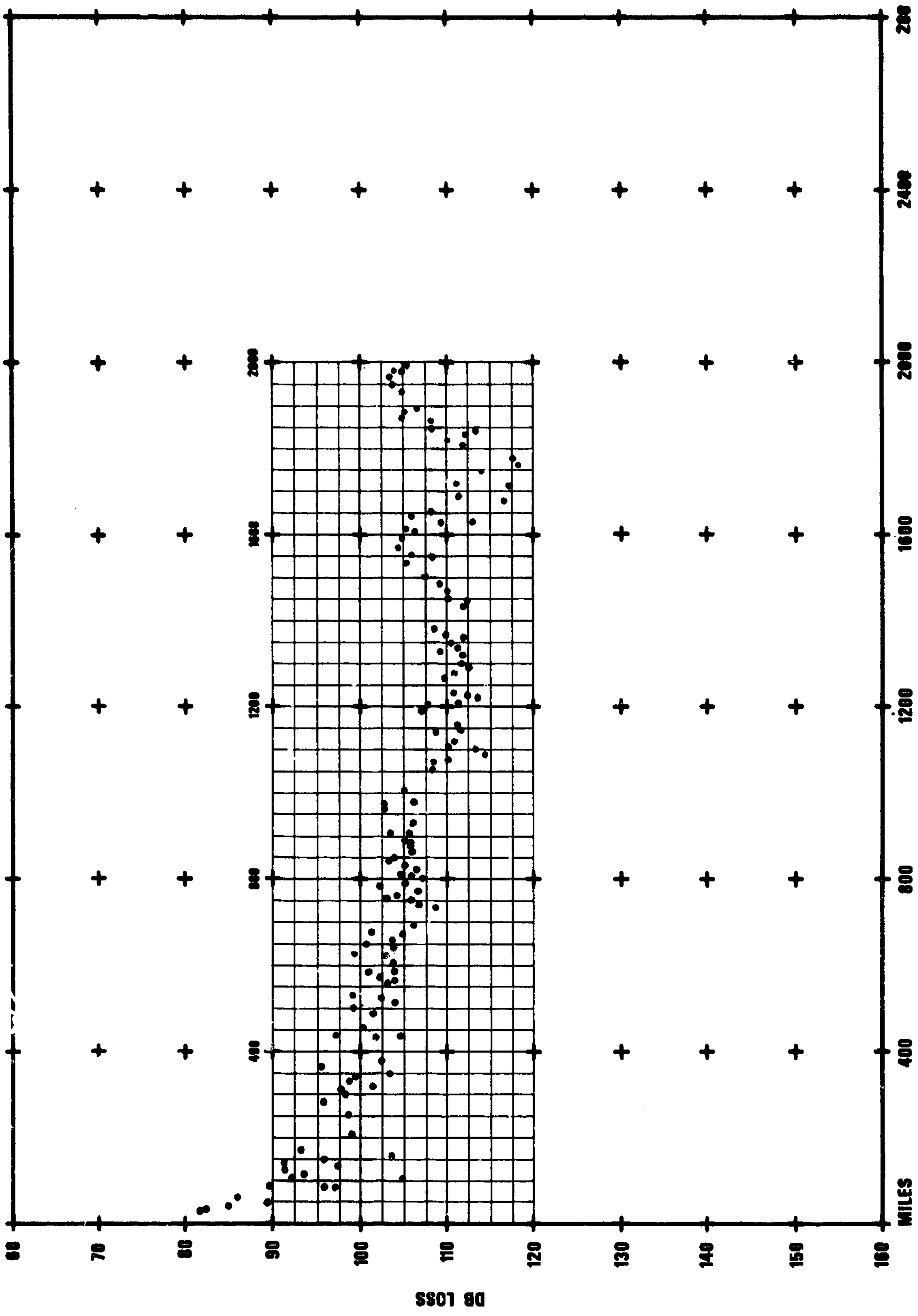

Figure 9. Measured and Predicted Loss Along San Diego Track For Deep Source/Axis Receiver

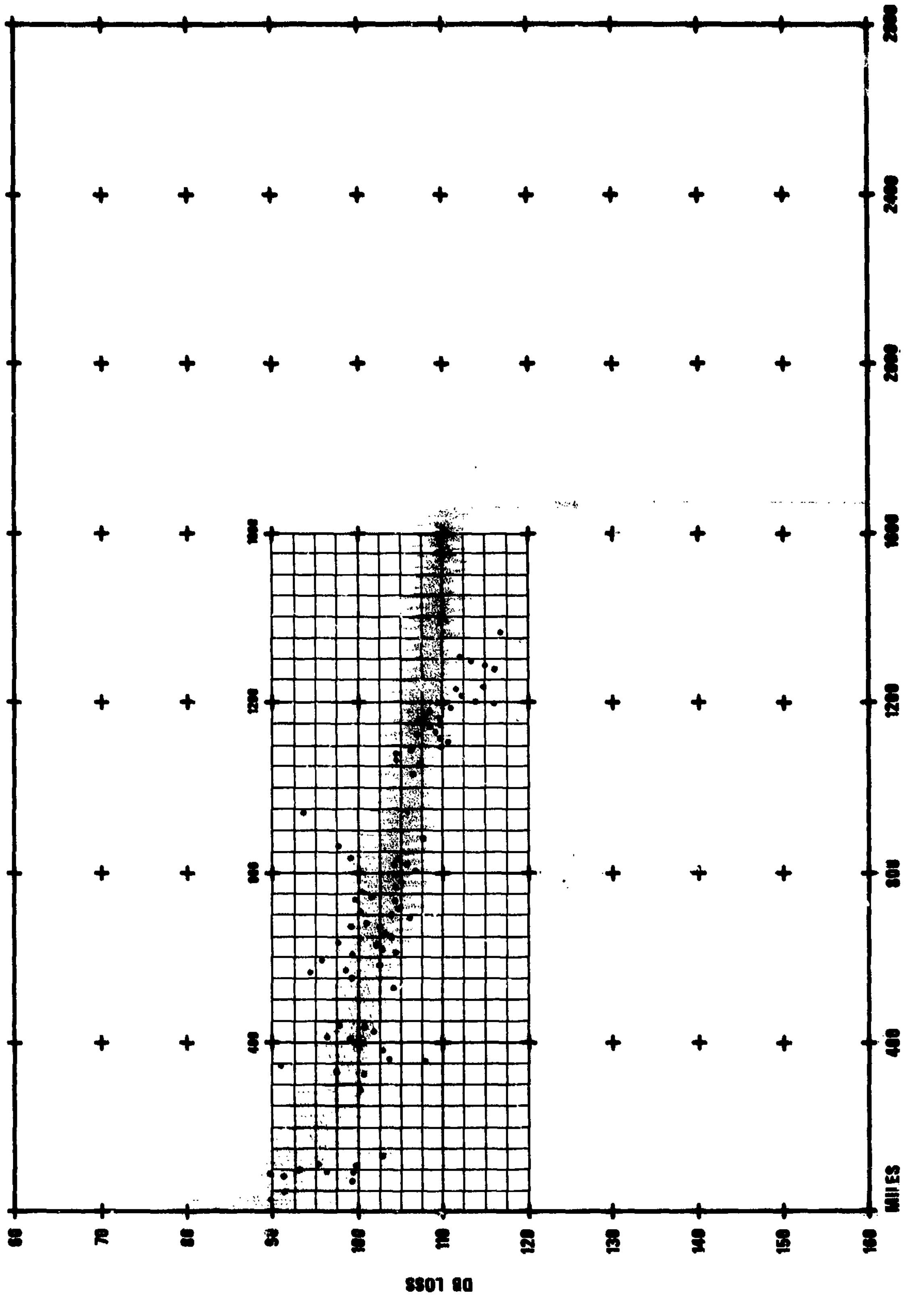

Figure 10. Measured and Predicted Loss Along Adak Track For Deep Source/Deep Receiver

Table V
Agreement Of FNWC Model Predictions With PARKA IIA Data (100 Hz)

SOURCE DEPTH	TRACK FROM FLIP	RECEIVER DEPTH	
		2500 ft. (Axis)	10,800 ft. (Deep)
Shallow	Due North	NS	NS
60 ft.	Due South	Very Poor	NS
	Adak	NS	NS
	San Diego	Inconclusive	NS
Deep	Due North	Very Good[1]	NS
800 ft.	Due South	NS	NS
	Adak	Very Good	Poor[3]
	San Diego	Good[2]	NS

(C) The FNWC model was less successful in using archival environmental data to predict losses for other tracks and other source depth-receiver depth combinations. The least successful predictions are those for tracks involving bottom interference (such as the track due South from FLIP) and where knowledge of the bottom is lacking.

Seasonal Effects

(C) The difference between summer (PARKA I) and autumn (PARKA IIA) 100 Hz propagation loss for near axis receiver and 60 foot source along the track due north from FLIP is illustrated in Figure 11. The PARKA IIA (November) measured losses are seen to be smaller than those measured during the PARKA I (August) exercise. Other curves of this type were compared to obtain the seasonal variations exhibited in Table VI which compares mean 100 Hz losses at 1400 n.mi. (Where loss curves are nearly flat) from a shallow (60 ft) source to a near-axis receiver and to a deep receiver. In the fall and in the winter, the propagation loss to 1400 n.mi is less for the near-axis receiver than for the deep receiver, whereas the deep receiver is seen to be better in the summer. This indicates that the best receiver depth for that location and for targets 1400 n.mi. due North is seasonally dependent.

NS - No Study Made
1. 50-500 nm (500 ft. Source Depth), no comparison made beyond 500 nm.
2. 300-1050 nm. Fair at range below 300 nm, poor at ranges exceeding 1050 nm.
3. Some agreement 300-800 nm.

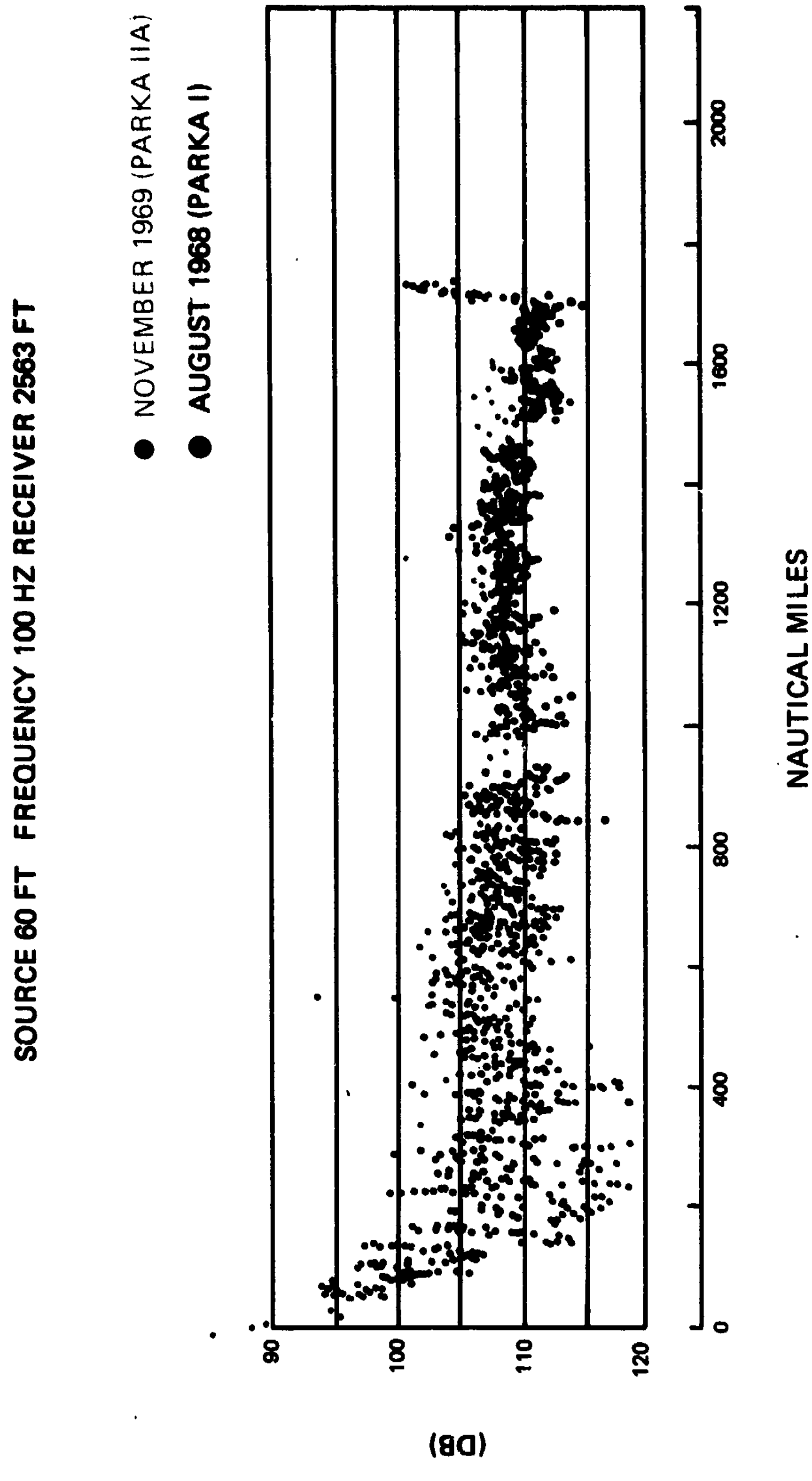

Figure 11. Measured Propagation Losses For Two Seasons – North Track

Table VI
Seasonal Dependence Of Propagation Loss

	PARKA I SUMMER		PARKA IIA FALL		PARKA IIB WINTER	
	OBSERVED	PREDICTED	OBSERVED	PREDICTED	OBSERVED	PREDICTED
AXIS RECEIVER	110 dB	110 dB	107 dB	107 dB	105 dB	108 dB
DEEP RECEIVER	106 dB	106 dB	111 dB	109 dB	111 dB	107 dB

100 Hz
60 FT SOURCE DEPTH
1400 MILE RANGE

Differences Between Tracks

(C) Figure 12 compares propagation loss measurements over different tracks for the same season, source depth and analysis frequency for two receiver depths. Both curves are for the shallow source and 100 Hz analysis frequency. The propagation loss over the East-West (FLIP-to-San Diego) track (red dots) is seen to exceed that measured over the North-Sound (FLIP-to-Alaska) track (black dots) for both receiver depths. The East-West track involves a sound channel axis of nearly constant depth, whereas the North-South track involves a shoaling sound channel axis where surface temperature decreases at the higher latitudes. This is illustrated in Figure 13. The coupling of the shallow source to the sound channel (near-axis receiver) improves as the axis comes up to meet the source as range increases to the North.

Transmission Path Stability

(C) Figure 14 presents the results of two propagation loss measurements made over the same path with two and one-half days separating the measurements. Since the earliest data was taken while the source ship was outbound from FLIP and the later data was taken when the source ship was inbound, the short range data points were the most widely separated in time (about 5 days). However, the positions in range and the peaks of the convergence zones measured outbound are in excellent agreement with those measured later.

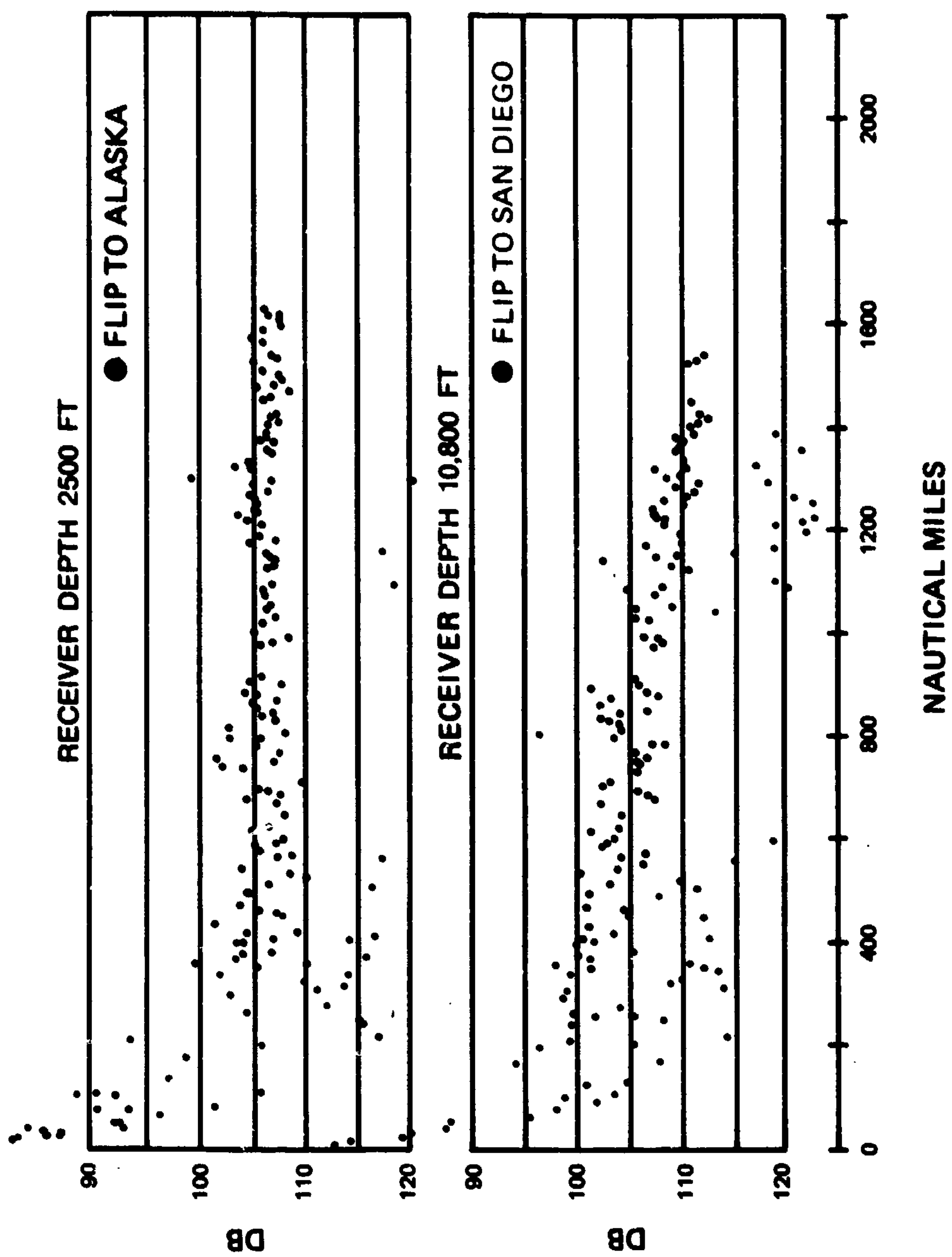

Figure 12. Measured Propagation Loss – Two Tracks

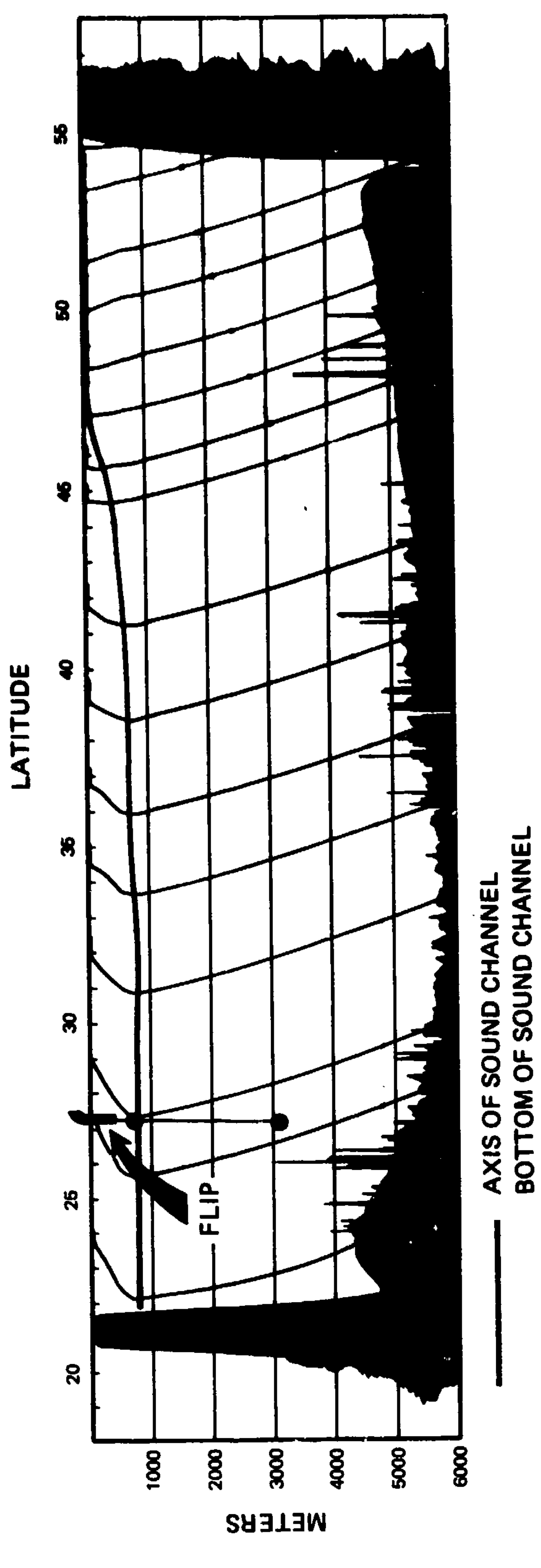

Figure 13. Sound Channel – North Track

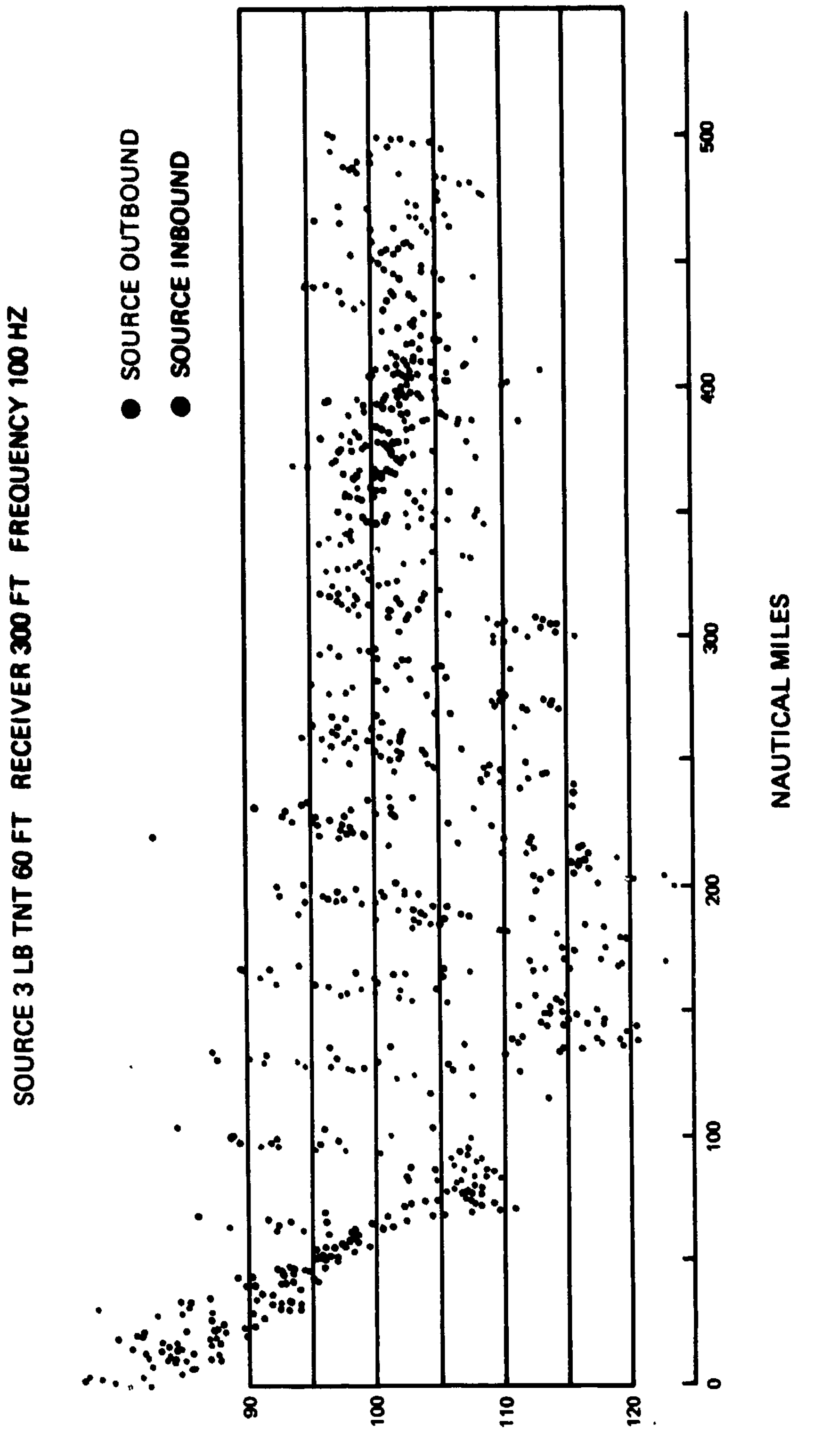

Figure 14. Measured Propagation Loss – Inbound and Outbound Runs

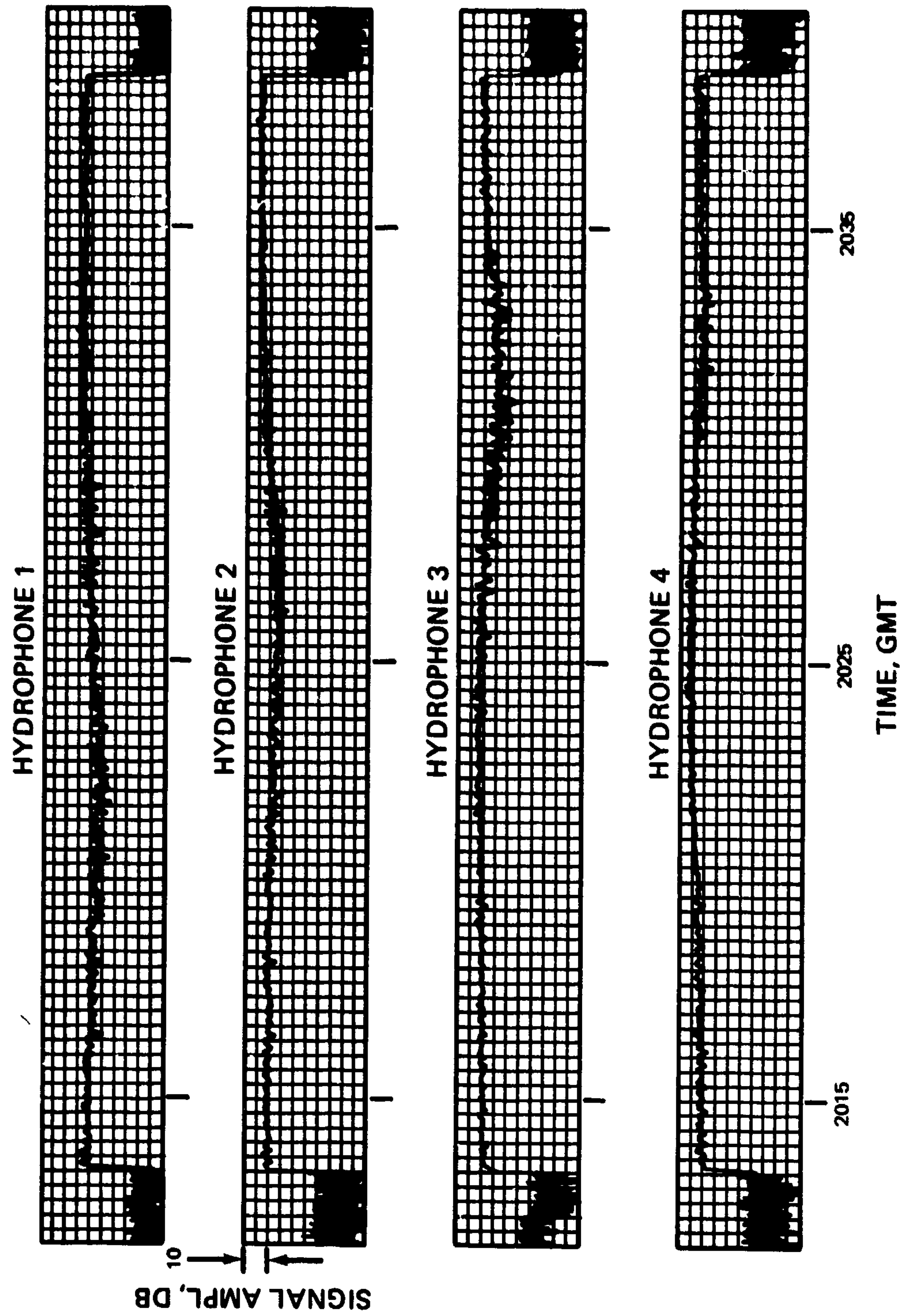

Figure 15. Time History of 178 Hz Signal Amplitude

(C) The interval of time between data points taken at the same range on the two exercises varies with range, with the total variation equal to twice the steaming time from FLIP to the range in question. The agreement between runs is good to ranges in excess of 200 nmi (representing more than a day's steaming, round trip). For these reasons it can be concluded that diurnal fluctuations in propagation are not significant for the conditions of the exercise.

(C) Short-term amplitude fluctuations were measured at the sound channel axis while the source ship was navigated (with respect to bottomed acoustic beacons) so as to maintain the 500 ft deep CW source at an approximately fixed position 420 miles to the northeast of the receiving array.

(C) Figure 15 shows the time history of the 178 Hz amplitude in a 1 Hz filter band received at each of four receivers. Figure 16 depicts the vertical distribution axis of the hydrophones suspended from FLIP at the sound channel axis depth for these measurements. The amplitude histories cover a period of about 30 minutes when the range rate between FLIP and the source was about 0.05 knot or about one inch per second. Consequently the change in range for the period shown was about 150 ft (5.3 λ at 178 Hz).

(C) The received level exhibits a short term fluctuation of 5 to 6 dB superimposed on a long term variation of less than $\pm$ 4 dB. The short term fluctuations appear to have about the same period as the period of surface waves.

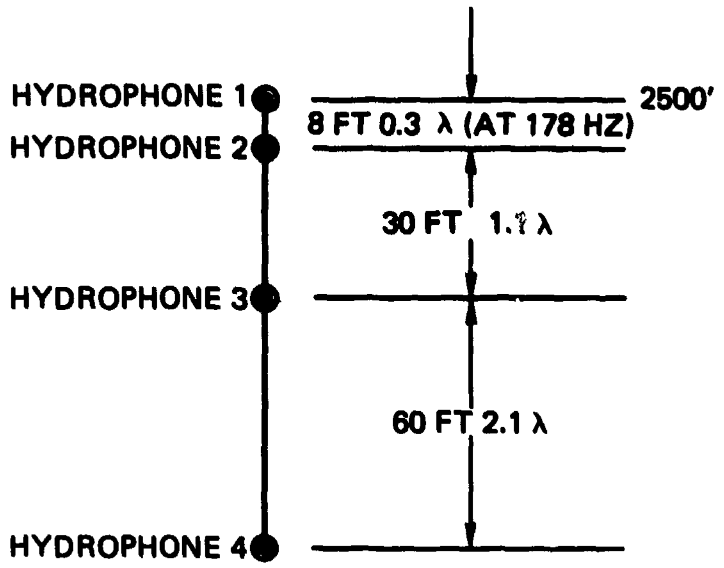

Figure 16. Vertical Distribution of Channel Axis Receivers

Coherence of Received CW Signals Over a Vertical Aperture

(C) The signals from the separate receivers were processed to derive the phase differences between pairs of receivers for the same period of time as for the amplitude histories discussed above. The results are presented in Figure 17. The upper trace shows the relative phase for eight foot (0.3 λ) spacing to remain small, wandering to, at most, 20 degrees from its average value. The middle trace, for 38 foot ($\sim$1.5 λ) spacing wanders with larger amplitude and different form, departing no more than 40 degrees from its mid-value of 110 degrees. The bottom trace, for 60 foot ($>$ 2 λ) spacing holds near 180^{o} quite steadily. The rapid fluctuations from 2031 GMT to 2035 GMT are caused by a $\pm$ 180^{o} ambiguity in the phase recording system.

Frequency Effects

(C) Comparison of PARKA IIA 25 Hz and 50 Hz propagation loss curves for all runs made with the shallow (60') explosive source show the 25 Hz loss to be consistently greater than the 50 Hz loss. The difference, 8 to 12 decibels, does not appear to vary with range or with receiver depth. It exists for all runs made with the shallow sources, (3 lb. TNT ship-dropped and air-dropped SUS charges) and for those made with the 800 foot depth aircraft-dropped SUS charges. However, the effect is not present in the two ship runs made with the 3 lb. TNT charges detonated at 500 feet.

(C) The explanation of these effects which are thought to be connected with calibration and image interference are being investigated.

Ambient Noise

(C) The PARKA IIA Experiment produced a large number of noise measurements taken at a variety of frequencies and depths. A sample of noise was taken aboard FLIP from every hydrophone prior to each shot, so that noise data were obtained at five frequencies (25, 50, 100, 180, and 400 Hz) and at three depths (300, 2500, and 10800 feet) throughout the experiment. In addition, AUTOBUOY, a self contained programmable deep diving instrument package, was employed to make approximately 30 minute duration noise recordings once each at 2600, 6400, 10000, and 14200 feet. These recordings were processed at eighteen frequencies covering the band 20 to 1200 hertz. The 300 foot data from FLIP were clearly influenced by the experimental set-up, and are not reported here. The deeper phones, although influenced at times by cable strumming or other extraneous noise, are considered to have measured ambient ocean noise for long periods of time. For these periods there appears to be no significant difference in ambient noise levels at these depths.

The AUTOBUOY data are in general agreement with the FLIP data. The total collection of AUTOBUOY data indicates no significant change in noise level with depth from 2600 feet to 14200 feet.

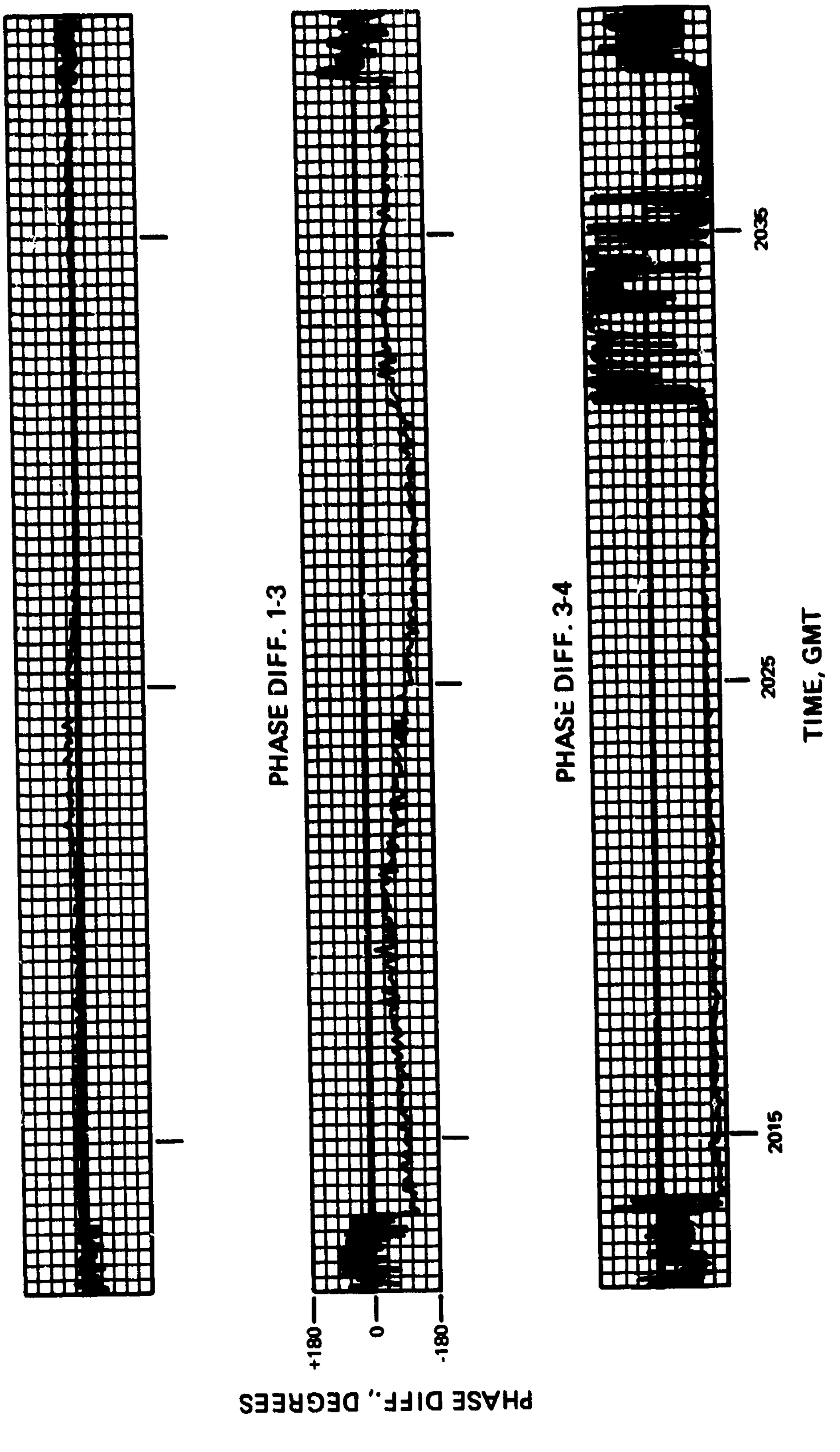

Figure 17. Variation With Time of Inter-Element Phase

RECEIVER DEPTH SELECTION

(C) The selection of a receiver depth to maximize system signal-to-noise should be made from consideration of many factors. Factors of major importance (depth dependence of propagation loss from expected target depths and ambient noise) were the subject of PARKA II measurements. Sufficient propagation loss data were obtained to establish the mean loss for many sets of conditions but sampling over the depth parameter has been limited to three depths (300, 2500, 10,800 ft.) in PARKA I; six depths (300, 2500, 2521, 2563, 2601 and 10,800 ft) in PARKA IIA and five depths (2500, 2521, 2563, 2601 and 10,800 ft) in PARKA IIB. The agreement between predicted and measured mean propagation losses achieved in the PARKA exercises indicates that depth dependence of propagation loss is predictable with some accuracy. However, ambient noise levels as a function of depth are not as well understood. Because of this, the following tabulations of best (of three) receiver depths are based solely on minimum propagation loss. Separate tabulations are made for each season, based on the cumulative results of the PARKA experiments.

Summer (PARKA I Data) (Due North track only)

Deep (10,800 feet) receiver better than axis received by ≈ 4 dB for shallow source at long ranges.

Near axis (2500 feet) receiver better by ~ 3 dB for deep source at long range but deep receiver better than near-axis receiver at short range.

Autumn (PARKA IIA Data)

(C) PARKA IIA, by measuring propagation loss over other tracks in addition to the North-South track used in PARKA I, provided considerable data from which receiver depth for the oceanographic autumn may be selected. Cursory examination of selected PARKA IIA propagation loss data leads to Table VII, a presentation of "best" (of the three) receiver depths for long range detections.

Winter (PARKA IIB Data)

(C) The PARKA IIB results for oceanographic winter showed that, for 100 Hz energy originating at a shallow (60 ft) source and propagating to a range of 1400 nmi, the mean propagation loss to a near-axis (2500 ft) receiver was 105 dB, six decibels less than the mean loss to the deep receiver.

Best Receiver Depth Dependent on Range

(C) The preferred receiver depths presented in Table VII are qualified by the several remarks accompanying the table. These qualifications are required because the PARKA IIA data show that best depth (in the sense of least propagation loss) changes with range,

Table VII
Receiver Depth Selections
(Oceanographic Autumn)

TRACK	SOURCE (TARGET) DEPTH		REMARKS
	Shallow (60′)	Deep (50′ or 800′)	
FLIP to Adak	Axis[1]	Axis[1]	1. Deep receiver best to 500 nmi.
FLIP to San Diego	Shallow[2]	Axis[3]	2. Limited data for ranges > 600 nmi. 3. Deep receiver to 1000 nmi, axis receiver superior by 3-5 dB for range > 1000 nmi
FLIP due North (Long Range) > 500 nmi	Axis	No Data	
FLIP due North (to 500 nmi only)	Deep	Deep	
FLIP to Oahu (to 330 nmi only)	Shallow[4]	Deep[5]	4. Deep receiver best for ranges < 150 nmi. 5. Shallow receiver best in convergence zones at all ranges
FLIP to 247° (True) (to 500 nmi only)	Shallow[6]	Deep	6. Deep receiver equivalent at ranges < 250 nmi.

Shallow receiver ~300 ft.
Near axis receiver ~ 2500 ft.
Deep receiver ~ 10,800 ft.

source depth, and season. For example, in order to cover most adequately the track due North from Kaneohe, one would want receivers at 2500 feet and 10,800 feet. The deeper receiver would provide better coverage against shallow targets at all ranges in the summer; and also against both shallow and deep targets at ranges < 500 nmi in the autumn and winter. The near axis receiver would be better for the other conditions.

DEPARTMENT OF THE NAVY
OFFICE OF NAVAL RESEARCH
800 NORTH QUINCY STREET
ARLINGTON, VA 22217-5660

IN REPLY REFER TO
5510/1
Ser 93/160
10 Mar 99

From: Chief of Naval Research
To: Commander, Naval Meteorology and Oceanography Command
1020 Balch Boulevard
Stennis Space Center MS 39529-5005

Subj: DECLASSIFICATION OF PARKA I AND PARKA II REPORTS

Ref: (a) CNMOC ltr 3140 Ser 5/110 of 12 Aug 97

Encl: (1) Listing of Known Classified PARKA Reports

1. In response to reference (a), the Chief of Naval Operations (N874) has reviewed a number of Pacific Acoustic Research Kaneohe-Alaska (PARKA) Experiment documents and has determined that all PARKA I and PARKA II reports may be declassified and marked as follows:

   Classification changed to UNCLASSIFIED by authority of Chief of Naval Research letter Ser 93/160, 10 Mar 99.

   DISTRIBUTION STATEMENT A: Approved for public release. Distribution is unlimited.

2. Enclosure (1) is a listing of known classified PARKA reports. The marking on those documents should be changed as noted in paragraph 1 above. When other PARKA I and PARKA II reports are identified, their markings should be changed and a copy of the title page and a notation of how many pages the document contained should be provided to Chief of Naval Research (ONR 93), 800 N. Quincy Street, Arlington, VA 22217-5660. This will enable me to maintain a master list of downgraded PARKA reports.

3. Questions may be directed to the undersigned on (703) 696-4619, DSN 426-4619.

Peggy Lambert

PEGGY LAMBERT
By direction

Copy to:
NUWC Newport Technical Library (Code 5441)
NRL Washington (Mary Templeman, Code 5227)
NRL SSC (Roger Swanton, Code 7031)
✓DTIC (Bill Bush, DTIC-OCQ)

PARKA II Acoustic Results, 16 December 1969, USL-PUB-6001, NUSC New London, 106 pages
(NUSC NL Accession # 006001)

PARKA II Interim Report, 18 December 1969, Contract N00014-69-C-0088, Bell Telephone Labs, 129 pages
(NRL SSC Accession # 85007061)

PARKA II-B ONR Scientific Plan 1-70, 15 January 1970, MC Report 04, Maury Center for Ocean Science (ONR), Unknown # of pages
(NUSC NL Accession # 051663)

Environmental Oceanographic Observations in Support of PARKA II-A Operation, 30 April 1970, HU-HIG-ITR-4, Hawaii Institute-Hawaii Institute of Geophysics, Unknown # of pages
(NUSC NL Accession # 058081)

PARKA II-A Bottom Loss Measurement, 29 June 1970, USL-R-2408, NUSC New London, 19 pages
(NUSC NL Accession # 002408) (DTIC # C008 441)

PARKA II-A Bottom Loss Measurement, 29 June 1970, USL-2211-023-70, NUSC New London, Unknown # of pages
(NUSC NL Accession # 185457)

PARKA II-A Experiment, Final Report - Final Draft, Volume 1, The Acoustic Propagation Measurements, 30 June 1970, Contract N00014-69-C-0088, Bell Telephone Labs, 81 pages
(NRL SSC Accession # 10013937)

PARKA I: Software Procedures Report, 1 July 1970, NUSC/NL Technical Memorandum No. 2211-033-70, NUSC New London, 109 pages
(NUSC NL Accession # 116963) (NRL SSC Accession # 85009135) (DTIC # C008 091)

PARKA II - A Briefing Report, November 1970, MC Report 004, Maury Center for Ocean Science (ONR), 32 pages
(NUSC NL Accession # 055573) (NRL Accession # 474985) (NRL SSC Accession # 85007058)
(DTIC # 513 631) ✓

PARKA I Experiment, Appendices, January 1971, MC Report 003, Volume 2, Maury Center for Ocean Science (ONR), 165 pages
(NRL Accession # 480369) (NRL SSC Accession # 85004880) (DTIC # 517 075)

Sound Propagation Through the Northwest Pacific Emperor Seamount Chain, 15 April 1971, 11 pages
(DTIC # 519 151) ✓

PARKA II-A, The Acoustic Measurements, August 1971, MC Report 006, Volume 1, Maury Center for Ocean Science (ONR), 118 pages
(NUSC NL Accession # 023515) (NRL Accession # 483765) (NRL SSC Accession # 85004882)